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### PULP-TIMBER RESOURCES OF SOUTHEASTERN ALASKA

By B. F. HEINTZLEMAN

*Assistant District Forester, Alaska District, Forest Service*

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#### FOREWORD

The southeastern section of Alaska has extensive forests of pulp-wood that are managed by the Federal Government for a sustained production of timber, excellent water-power resources for industrial use, tidewater transportation both from the woods to the mills and from the mills to markets, and an equable climate that permits of plant operation and unhindered shipping throughout the year. With these advantages this section of Alaska, in the opinion of the United States Department of Agriculture, has an excellent opportunity to become a great permanent paper-making region, with model industrial towns, thoroughly equipped, efficient plants, and a population of skilled mill and woods workers. The purpose of this publication is to furnish information on the forest resources of the region to those interested in pulp and paper manufacture. It is a companion publication to one issued by the Federal Power Commission in 1924.<sup>1</sup>

#### THE REGION

#### GEOGRAPHY AND TOPOGRAPHY

Southeastern Alaska consists of a long, narrow strip of mainland and an adjoining archipelago of hundreds of islands, extending

<sup>1</sup> DORT, J. C. REPORT TO THE FEDERAL POWER COMMISSION ON THE WATER POWERS OF SOUTHEASTERN ALASKA. 172 p., illus. Washington, [D. C.] 1924.

southeasterly from the main body of the Territory along the west side of northern British Columbia. (Fig. 1.) It is about 350 miles long and 120 miles wide. The mainland strip and numerous islands are penetrated and separated by an intricate system of narrow, navigable straits, inlets, channels, canals, and bays, which gives the region a total shore line of about 9,000 miles and renders a very large proportion of it readily accessible by water. (Fig. 2.)

This region possesses a high relief and rough topography. It is included in the broad mountainous belt, known as the Pacific Mountain system, which parallels the coast of British Columbia and of Alaska as far north and west as the Aleutian Islands. The dominant feature of this mountain system in southeastern Alaska is the Coast Range, a rugged, snow-capped mountain mass, which lies on the mainland along the international boundary and extends the entire length of the region. The islands are made up of a number of ranges not sharply differentiated from the Coast Range, but in the main of lower relief and less rugged topography and having relatively small areas covered with permanent snow and ice fields. The mountains of the mainland range are 5,000 to 6,000 feet in height, with an occasional peak reaching 7,000 to 9,000 feet; the islands have a relief of 3,000 to 4,000 feet. The slopes, both on the islands and on the mainland, are steep and heavily dissected, and the shore lines are largely bold and rocky. The bottoms of the narrow sea channels fall off quite abruptly at the shores, and depths of 100 to 200 fathoms are common.

This region gives the impression of a mountainous zone that has been partially submerged, former valleys constituting the long, narrow, tidal waterways and the upper portions of the ancient ridges appearing as the present islands. (Fig. 2.)

There are only four large rivers. Three of them, the Stikine, Taku, and Alsek, rise in the interior plateau region in Canada and break through the great barrier of the Coast Range to reach the sea. The fourth, the Chilkat, occupies a long valley reaching inland between parallel ranges at the northern end of the region. All of the other streams are small since either they are on the islands or their catchment basins are confined to the seaward slopes of the mountain range which parallels and adjoins the coast of the mainland.

The total land area of the region, inclusive of all federally owned lands lying east of the 141° meridian, is about 22,738,000 acres (35,527 square miles), which is 6 per cent of the total area of the Territory of Alaska. The mainland strip covers approximately 13,700,000 acres. Sixty-seven islands have areas in excess of 2,500 acres each. The following islands, 17 in number, each exceed 50,000 acres in area:

	Acres		Acres
Prince of Wales-----	1,427,660	Wrangell-----	140,612
Chichagof-----	1,346,465	Mitkof-----	135,190
Baranof-----	1,028,605	Kosciusko-----	119,155
Admiralty-----	876,330	Zaremba-----	116,700
Revillagigedo-----	747,305	Kruzof-----	110,320
Kupreanof-----	697,320	Annette (Indian reserv- ation) -----	86,740
Kuiu-----	477,670	Gravina-----	57,550
Etolin-----	219,740	Douglas-----	50,060
Dall-----	162,640		

Southeastern Alaska is essentially a timber-producing region. Perhaps less than 1 per cent of the area is suitable for agricultural

use, the rest being unsuitable for farming because of rough topography and thin soil. With the aid of mild temperatures and abundant rainfall, however, the thin soil of the region supports

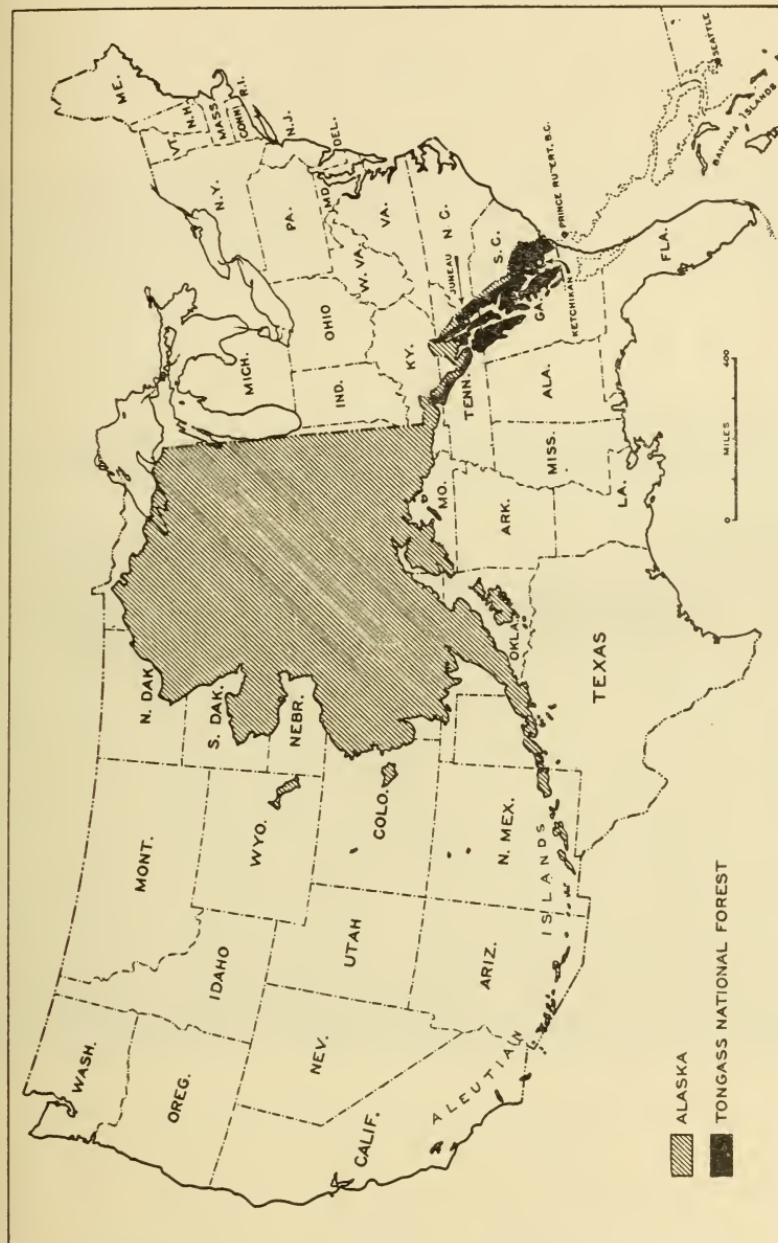


FIG. 1.—Alaska and the Tongass National Forest. Size and distances in relation to the United States

extensive stands of rapidly growing trees. Nearly all of the land is owned by the Federal Government, and 16,547,000 acres, or about 73 per cent of southeastern Alaska, has been included in the national-

forest system to be administered primarily for the continuous production of timber crops and a sustained yearly output of raw material for local wood-using industries.

#### COMMUNICATIONS

Southeastern Alaska has no rail or motor road connections with the main body of the United States. The nearest transcontinental railroad point is Prince Rupert, British Columbia, a Pacific coast



FIG. 2.—Hawk Inlet and Stephens Passage. The hemlock forests of southeastern Alaska are readily accessible to the network of protected sea channels

terminal of the Canadian railway system, 50 miles from the south boundary of Alaska and 95 miles from Ketchikan, the nearest Alaskan town. All transportation to and from the Territory is by water, principally through the sheltered "inside passage," which lies back of the island groups that extend from Puget Sound to the north end of the region. (Figs. 2 and 9.) Ketchikan and Juneau, the two largest towns, are 660 and 900 miles, respectively, from Seattle. Yearlong steamship service is provided from Seattle and from Vancouver, British Columbia. The general course from Seattle

is northwest rather than north. Ketchikan, the first Alaskan port, is almost as far west as it is north of Seattle, and its standard time is one hour later.

The United States Army operates a commercial cable and telegraph system between Seattle and the principal towns of Alaska.

#### CLIMATE

In view of the high latitude, an outstanding climatic feature of this section is the mild winter temperature. The mean temperatures for the winter months at the various towns range from  $29\frac{1}{2}^{\circ}$  to  $35^{\circ}$  F. The January mean for Sitka is  $5^{\circ}$  higher than that of Boston, Mass., and only  $1.2^{\circ}$  lower than that of Washington, D. C. Zero temperatures occur infrequently, the official weather records for 30 years at Juneau, located in the northern part of the region, showing a total of only 55 days on which the temperature fell to zero or lower. The lowest recorded temperature there during this same period was  $-15^{\circ}$ , approximately the same as has twice been recorded at Washington, D. C.

The mean summer temperature is between  $50^{\circ}$  and  $55^{\circ}$ , which is much cooler than that at Atlantic seaboard points.

The precipitation is extremely heavy, the yearly mean for various places being: Juneau, 81 inches; Sitka, 83 inches; Ketchikan, 159 inches. There is no pronounced dry season as in the Pacific Coast States, but the rainfall in fall, the wettest season, is from two to three times that of an equal period in May, June, and July, the driest months. Snow does not accumulate to great depths at sea level, because much of the winter precipitation there is in the form of rain. The towns are practically free of snow the greater part of the winter.

The above statements apply only to low elevations near tidewater, but it is in such locations that most of the activities of this region are carried on. The winter temperatures decrease very rapidly with increase in elevation and progress inland, precipitation is much heavier on the higher mountains, and at altitudes above 1,000 feet snow covers the ground for not less than four months of the year.

There are no climatic factors which prevent or seriously hinder the operations of woodworking establishments throughout the year. The main seaways and most of the small inlets are free of ice throughout the winter, so that water transportation is possible at all times. The logging season is usually considered as covering eight months, April 1 to December 1, but winter logging is practicable in many localities, and some concerns are operating for periods as long as 11 months.

The heavy rainfall and high relative humidity of the average summer give this region a very low forest-fire risk.

#### GEOLOGY

In general the rocks of southeastern Alaska comprise two distinct groups. A belt of metamorphic sediments skirts the shore of the Pacific and largely makes up the bedrock of the islands of British Columbia and southeastern Alaska, as well as some of the most westerly portions of the adjacent mainland. East of this belt is a great zone of intrusive rocks which forms the core of the Coast Range.

The general trend of the structural lines is northwest, parallel to the coast and to the long axis of the mountain ranges.

The Coast Range intrusives occupy about one-half of the land area of southeastern Alaska. They are granitoid rocks, mainly diorite and granite. They form the principal rocks of the mainland mountain belt, 50 to 80 miles wide, which parallels the coast and separates the plateau region of British Columbia from the Pacific Ocean. Related rocks occur outside this main belt and form important features of the bedrock of many of the islands. They constitute the core of the mountain range extending through the middle of Baranof Island, Chichagof Island, and the peninsula between Glacier Bay and the Pacific Ocean. They are also prominent on the west side of Admiralty Island and probably underlie much of the interior of the island. Farther south they occupy a large part of Prince of Wales Island.

These outlying granitoid masses are nearly always elongated in the same direction—northwest and southeast—as the main zone in the Coast Range.

Bordering the main intrusive core of the Coast Range on the southwest and parallel to it is a band of closely folded crystalline schists several miles in width which has been traced the full length of southeastern Alaska. The strata are essentially siliceous mica schists, feldspathic schists with intercalated amphibole and chlorite schists, and occasional beds of crystalline limestone. On the southwest side of this band the beds become less schistose, and "black slates" and graywacke predominate. Intercalated beds of altered lavas and tuffs, usually called greenstones, gradually find place in the slate belt and farther southwest great thicknesses of these greenstones occur. Such a belt of massive greenstone beds is well exposed in the shores of Tongass Narrows at Ketchikan, the west end of Cleveland Peninsula, Cape Fanshaw, Glass Peninsula, and the west side of Douglas Island.

Beyond this greenstone belt toward the outer coast the beds of one formation can not be traced for any great distance northwesterly as can the rocks along the mainland. This is largely due to the irregular batholithic intrusives, similar in composition to the Coast Range diorite and granite, which, as mentioned above, occupy the central portion of most of the islands. In general, however, the formations to the northeast and southwest of these cores consist of parallel belts of much the same rocks as are found on the west side of the mainland intrusive core, namely, schists, limestones, slates, graywacke, greenstone, and conglomerates.

Steep topography prevents the accumulation of deep soil over these rocks, except occasionally in the stream beds. The heavy rainfall, however, enables dense forests to grow on thin soils, wherever the elevation does not make the climate too severe. The heaviest stands of timber, including the best stand of spruce, are found on ground underlaid with limestone or other sedimentary rocks, but good commercial timber grows over all of the various geologic structures mentioned. The granitic intrusions are the cause of the rough topography and consequently strongly influence the distribution of the forest and the cost of logging.

## TIMBER RESOURCES

## GENERAL DESCRIPTION OF THE FOREST

Southeastern Alaska is within the range of the extensive "coast forest," which occurs in western Oregon, Washington, and British Columbia and along the southern coast of Alaska as far north and west as the Aleutian Peninsula and Afognak Island. As this coast forest pushes northward from the most favorable part of its range, in Washington, it gradually loses some of its species, the timber line decreases in altitude, the trees become smaller, and the species of the higher elevations gradually work their way down toward sea level.

As found in southeastern Alaska, the coast forest is predominantly a mixed stand of western hemlock and Sitka spruce. In many places western red cedar and Alaska cedar are associated with the predominant species in small proportions. Any one of these four species may be found occasionally in a pure stand of small extent. The forests have an almost tropical density of trees and underbrush. (Fig. 3.) In the usual mixed stand hemlock with some cedar forms a dense main cover, and this is overtopped by the more light-demanding spruce, which occurs singly or in small groups. Small bushy saplings of the shade-resistant hemlock and cedars, various species of blueberry (*Vaccinium*), and devil-club (*Echinopanax horrida*), and other shrubs form a dense understory. Down timber, which decays very slowly because of almost continuous saturation from an abundant rainfall, occurs in profusion, and a carpet of moss often 6 inches or more in thickness covers the decaying logs and the entire forest floor.

The stands of timber are even aged; many age classes are represented in the forest as a whole; and the stands of the older age classes are greatly in the majority, perhaps three-fourths of the commercial timber of the region being mature and overmature. The even-aged stands are characteristic of western hemlock and Sitka spruce; the great number of age classes and the preponderance of old timber are to be expected in an extensive virgin forest.

The average stand per acre for the commercial forests as a whole is about 25,000 board feet, but the individual logging units vary widely from this average. A volume of 30,000 to 40,000 board feet per acre is common on many extensive areas, and 50,000 feet or more per acre frequently occurs on small units. The majority of the merchantable trees are from 2 to 4 feet in diameter and from 90 to 140 feet in height.

The forest cover extends from the edge of tidewater to an altitudinal limit of about 2,750 feet in the southern part of the region and 2,000 feet in the northern sections. At an elevation of about 1,500 feet the commercial timber gives way to stands of dwarfed, limby trees, which are designated "subalpine" and classified as noncommercial. Because of the prevailing steep slopes the commercial forests form relatively narrow bands along the shore lines of the mainland and islands, rarely extending inland more than 5 miles, except along the valleys of the few large streams.

It is estimated that 75 per cent of the commercial timber lies within  $2\frac{1}{2}$  miles of tidewater.

The forests of commercial value are broken into large blocks by frequent extensive noncommercial areas of "scrub," as the open stands of somewhat dwarfed timber are called, and by muskegs of peat which carry only isolated small trees.

Trees with dead spike tops are a conspicuous feature of the non-commercial scrub areas and of the cedar areas. Spike-topped individuals, so decadent as to be classed as unmerchantable, are fairly prevalent also in the overmature hemlock-spruce stands, but their effect in depreciating the value of these stands is likely to be over-



FIG. 3.—Mixed stand of mature western hemlock and Sitka spruce

estimated. They form a relatively small percentage of the timber, which as a whole is of good quality. Only a few spike tops occur in the extensive hemlock-spruce areas of mature timber and of piling-sized young timber.

#### VOLUME OF STANDING TIMBER

Most of the standing timber of southeastern Alaska is in the Tongass National Forest. The principal timber-bearing areas outside the Tongass Forest are Annette Island and the valley of the Chilkat River, the former an Indian reservation and the latter largely public domain. There is little timber in private ownership. The total amount of standing timber outside the national forest does not exceed 1,500,000,000 board-feet.

The volume of commercial timber by species on the Tongass National Forest is conservatively estimated in Table 1.

TABLE 1.—*Volume of commercial timber on the Tongass National Forest*

Species	Feet board measure	Per cent
Western hemlock...	58,000,000,000	74
Sitka spruce...	15,800,000,000	20
Western red cedar...	2,350,000,000	3
Alaska cedar...	2,350,000,000	3
Total...	78,500,000,000	100

In round numbers 3,000,000 acres of national-forest land carries timber of commercial value, so that on the basis of the above estimate of volume the average stand per acre is 26,000 board feet. In addition, areas of somewhat poorer timber, totaling perhaps 1,000,000 acres, occupy a marginal position in that they are classed as non-commercial at present but should become valuable in the future. Another 1,000,000 acres carries a growth of scrub timber considered valueless.

#### SPECIES

##### WESTERN HEMLOCK (*Tsuga heterophylla*)

Western hemlock is by far the most common tree of southeastern Alaska, occurring throughout the region and constituting the great bulk of the commercial timber. In association with other species it forms dense forests from tidewater to elevations between 1,500 and 2,000 feet. (Figs. 2, 3, 4, and 5.)

In the characteristic even-aged stands the mature tree reaches an average size of from 3 to 4 feet in diameter and from 100 to 140 feet in height. It has a long, slender bole, and a short, narrow crown, and as the under branches are shed readily the trunk is free of large knots. Below the lower branches the trunk has a very gradual taper.

The trees are commonly sound when young, but when they reach a diameter of 3 to 3½ feet, by which time they are largely overmature, they are affected by disease, and rapidly develop spike top and a serious heart rot. Many of these old, overmature trees are so defective as to be classed as unmerchantable. The greater part of the log output in stands where these defective trees occur comes from intermixed younger timber, which carries little defect. Hemlocks on the poorest sites and occurring as scattered trees in pure spruce stands frequently have deeply "fluted" lower trunks, but in the commercial forests as a whole fluting is not an important factor.

Hemlock is one of the predominating species of the poorly drained scrub and muskeg areas, which are extensive in this region. Here the trees occur as isolated individuals or in very open stands, and are short, heavily limbed, and otherwise of poor quality. Such timber is classed as noncommercial.

Western hemlock is an excellent wood for a great variety of uses. It is moderately strong, light in weight when dry, fine grained, light in color, and almost tasteless and odorless. It is hard enough to stand up well under heavy wear, although sufficiently soft to be worked easily. It is especially good for flooring, for which it is widely used; and is satisfactory for many other kinds of construction

material from heavy timbers to inside finish. It is superior to eastern hemlock as a pulping wood and is in good demand for boxes and crates.

Hemlock is used extensively as piling for the construction of fish traps, which are operated in the coastal waters of Alaska by the salmon-canning industry. Many of the sticks cut for this purpose are from 90 to 130 feet in length. Hemlock ties are now sawn in quantity by the local mills for use on the Alaska Railroad. Very little hemlock lumber is being cut in Alaska because it can not profitably be shipped to the general market in competition with Puget Sound hemlock. The local consumption is increasing, however, as the merits of hemlock lumber become better known.

The high value of western hemlock in pulp and paper manufacture has been fully established by the paper mills of Oregon, Washington, and British Columbia, which use a greater quantity of this wood than of any other species. Western hemlock makes excellent mechanical and sulphite pulp and enters into various classes of paper, newsprint being the principal product. The Forest Products Laboratory, United States Forest Service, Madison, Wis., gives the average output of pulp per cord of 100 cubic feet of solid wood as 2,160 pounds, bone-dry, by the mechanical process and 1,050 pounds, bone-dry, by the sulphite process.

The outstanding proportion of hemlock used by the pulp mills of the Pacific coast is shown by the following figures from the United States Bureau of the Census on the pulpwood consumption of the three Pacific Coast States for 1926:

	Cords
Western hemlock	300, 505
Sitka spruce	77, 555
True firs (genus <i>Abies</i> )	76, 421
Others	29, 532
Mill waste	54, 743
 Total	 538, 776

#### MOUNTAIN HEMLOCK (*T. mertensiana*)

Mountain hemlock is largely confined to the higher altitudes but occasionally is found near sea level on rocky sites. It is largely inaccessible and is not important commercially. The tree is quite similar to western hemlock in appearance, but is smaller and the trunk has more taper and is less clear of branches and knots. The quality of the wood is about the same as that of western hemlock.

#### SITKA SPRUCE (*Picea sitchensis*)

Sitka spruce occurs from tidewater to an elevation of 1,500 feet. The average mature tree is about 5 feet in diameter and 160 feet in height, but trees with a diameter of 7 feet and a height of 200 feet are common. The largest known spruce tree in Alaska is 14½ feet in diameter at a point 6 feet from the ground. The boles are well formed above the pronounced butt swell characteristic of this species and are clear of branches well toward the tops. (Fig. 4.) In the usual mixed forest the faster-growing and more light-demanding spruces are larger in diameter than the hemlocks and exceed them in

height. The large size and straight, clean, smooth-barked trunk of the spruce make it a distinctive and very impressive tree. It is commonly sound and straight grained but on exposed sites is much

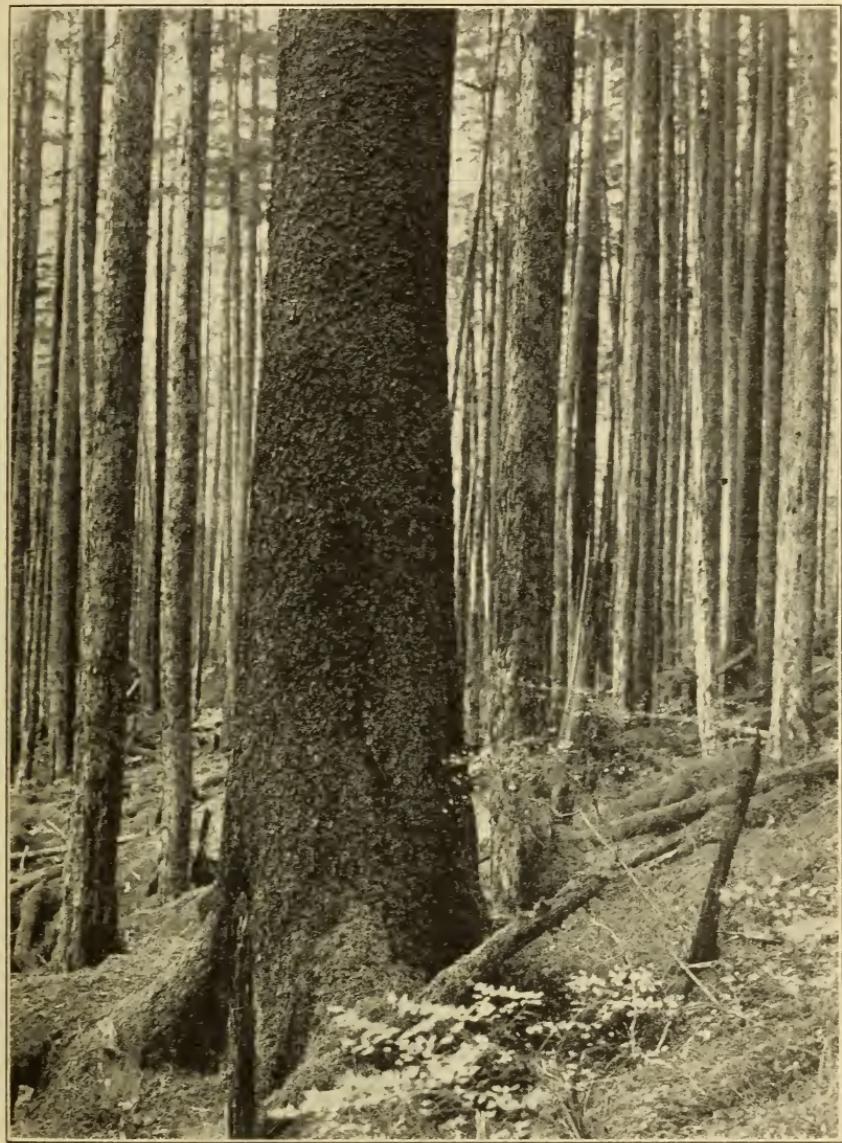


FIG. 4.—A fair-sized old Sitka spruce in a good stand of young hemlock. The total volume of hemlock and spruce in such stands is 30,000 to 50,000 board feet per acre

subject to wind-shake and spiral grain. The most common defect of overmature trees is butt rot.

Spruce is the principal saw-timber tree of this region and is manufactured into all of the usual forms of lumber and into airplane stock. It is excellent box material, and much of the low-grade

lumber is remanufactured into packing cases for the Alaskan salmon industry. The export of high-grade spruce lumber from Alaska started during the World War, when much airplane stock was furnished, and since then a constantly increasing amount of clear spruce for airplanes and other special purposes has been sent out by the local mills and transshipped through Seattle to other North American and to foreign markets. Full-cargo shipments of merchantable-grade lumber are made at irregular intervals to Atlantic and trans-Pacific ports.

Sitka spruce is generally conceded to be the best pulping wood on the Pacific coast. It compares very favorably with white spruce, the standard pulpwood of eastern North America. The average yield of pulp per cord of 100 cubic feet of solid wood, as determined by the Forest Products Laboratory is 2,100 pounds, bone-dry, by the mechanical process and 1,080 pounds, bone-dry, by the sulphite process.

Sitka spruce is less used than hemlock for pulp in the Pacific Coast States because of the keen competition of the sawmills for spruce logs and the suitability of the less expensive hemlock for the grades of pulp and paper manufactured there. It is unlikely that much competition for spruce will develop in Alaska between pulp mills and sawmills as the mixed hemlock-spruce forests are preponderately hemlock and will never be attractive for an extensive spruce sawmill development.

The position of the south coast of Alaska (Dixon entrance to Afognak Island) as regards the total supply of Sitka spruce on the Pacific coast is shown by the following estimates made by the Forest Service:

	Billion feet b. m.
Alaska (south coast)	18
British Columbia <sup>2</sup>	15
Washington	7
Oregon	4.5
 Total	 44.5

#### WESTERN RED CEDAR (*Thuya plicata*)

Western red cedar is limited in its range in the Territory to the southern half of southeastern Alaska. Frederick Sound marking its northern limit on the Pacific coast. It reaches its best development below an elevation of 500 feet. Mature trees have an average diameter of 5 to 6 feet and a height of 100 to 125 feet. They are limby, heavily tapered, and subject to severe heart rot. Trees of pole size are well formed and sound.

The best trees are those occurring as scattered individuals or in small groups in stands of hemlock and spruce. The trees of the pure cedar type of forest average somewhat poorer in quality but are sufficiently good to be classed as merchantable. The open stands of cedar and other species found so commonly on the swamp soils are uniformly poor in quality and are not considered merchantable, the trees being short, limby, and defective.

The western red cedar of Alaska is excellent shingle material because of its close grain, deep color, and fine texture and is consid-

<sup>2</sup> This estimate does not include other species of spruce in the interior.

ered primarily valuable for this use. It will also produce short boards and strips for specialized uses; but knots, seams, and heart rot preclude the manufacture of any appreciable percentage of the logs into siding and other high-grade lumber. Many of the younger trees are suitable for telephone poles. The cedar of Alaska will probably be utilized in fairly large quantities after the depletion of the cedar stands of Washington and British Columbia has progressed further.

ALASKA CEDAR (*Chamaecyparis nootkatensis*)

Alaska cedar is found throughout southeastern Alaska. It occurs from tidewater to the altitudinal limits of tree growth but is most prevalent and reaches its best development at elevations between 500 and 1,200 feet.

The best trees are found in small groups scattered through the hemlock and spruce forests. The trees of the extensive areas on which cedar predominates are in the main of small pole size and produce a very light volume per acre, but occasionally small patches of excellent cedar timber are found within these areas. Such good stands are usually less than 10 acres in extent, and have trees ranging from 18 to 36 inches in diameter and 75 to 90 feet in height.

Trees over 3 feet in diameter usually carry much heart rot in the first 16-foot log. The extensive bark-peeling operations of the Indians in earlier days have produced many "cat faces" and much vertical check, rendering one-third to one-half of the first log useless. Spiral grain and small knots are quite common. The best trees are those about 24 inches in diameter.

Alaska cedar is not cut in quantity as it is not well known in the markets. Its qualities and field of usefulness have not been studied carefully, but results obtained in local use indicate a high value for specialized purposes and there should eventually be a good demand for it. It is of very fine texture, easy to work, has a bright yellow color, takes a beautiful satin finish, and is extremely durable. It is considered valuable for pattern making, furniture, toys, turned articles, and cabinetwork. A pronounced odor which repels moths makes it valuable for chests. It has long been used locally for boat building and for telephone poles. Battery boxes and battery separators are now being made of it in British Columbia. While costly to log and mill because of the scattered occurrence of the trees and the amount of defect that must be handled, its use as a specialty wood will give the output a high value.

NORTHERN BLACK COTTONWOOD (*Populus trichocarpa hastata*)

Cottonwood occurs in quantity only on the valley floors of a few large mainland streams, principally the Stikine and Taku Rivers.

Mature trees reach an average diameter of 3 feet and a height of 80 to 90 feet. Though black heart and black knots are common on mature trees, extensive areas of immature trees of excellent quality are found.

Cottonwood in this region has a prospective use for pulp of certain grades. The small supply in southeastern Alaska might be augmented from the Canadian sections of the same river valleys.

## FOREST TYPES

The vegetative cover of any region is made up of a number of distinct plant associations, each with certain dominating species or characteristics of form that distinguish it from the others. Such of these associations as are dominated by tree species are known as forest types. They are generally named to show the dominating species or other distinctive feature, and are used as the unit in forest descriptions and in formulating methods of forest management.

Only the broad general types into which the forest cover of southeastern Alaska can be readily divided are described here. No attempt is made to segregate and describe the many subtypes, which, important as they may be to the local forester and lumbermen, are but variations within the general types.

## WESTERN HEMLOCK-SITKA SPRUCE TYPE

The western hemlock-Sitka spruce type is the most prevalent commercial timber type in southeastern Alaska. Western hemlock is the most abundant species in the type. Its principal associate is spruce, which contributes from 5 to 35 per cent of the timber volume. Western red cedar and Alaska cedar are also represented in the type. Stands typical of millions of acres contain approximately 75 per cent hemlock, 20 per cent spruce, and 5 per cent cedars.

The forests of this type can be roughly divided into three general classes based primarily on age.

*Overmature with young-growth timber*

This includes the stands in which an old, overmature growth of trees is being replaced by a younger age class. In this extensive forest region there are stands showing this replacement in all its stages, but those in which it is well advanced are the most numerous. In such cases the overmature timber is of quite open density and is composed of overmature hemlock 3 to 5 feet in diameter and of scattered larger spruce.

The trees of the younger age class range from 8 inches to 2 feet in diameter, and are tall, well-formed, clean-boled, and sound. Cedars ranging in size and quality from excellent poles to large, overmature trees are scattered singly or in small groups throughout the stand. The average volume per acre is about 25,000 board feet.

This combination of overmature and young timber constitutes about half of the commercial timber of the region and must be relied upon to furnish a corresponding portion of the wood supply for pulp mills. Its yield will be primarily pulp timber, but much spruce saw timber of large size, cedar-shingle timber, and long hemlock piling can be segregated from the pulpwood output. The younger growth understory will furnish perhaps more than half of the timber logged from this class of forest. Many of the large, old trees are too defective to be classed as merchantable and will not be removed in logging.

*Mature timber*

Mature timber includes stands which consist of mature trees and which have not yet begun to open up and let in the young growth.

(Fig. 3.) The trees range in diameter from 2½ to 4 feet and are of excellent quality. The average yield is from 30,000 to 40,000 board feet per acre.

Although stands of this kind are not so prevalent as those of the first class mentioned, extensive areas of this mature timber are scattered throughout the region. They will be an important source of pulpwood supply, and their heavier yield per acre will aid materially in reducing logging costs on operating units composed, in the main, of overmature and young growth timber.

#### *Young growth*

Young growth is that from which an older decadent overstory has been entirely or almost entirely eliminated. (Fig. 5.) The trees range largely from 1 to 2½ feet in diameter and from 90 to 150 feet in height. They are clean stemmed, well formed, and sound. A density of 60 to 100 merchantable trees to the acre is very common, and the volume averages 30,000 board feet. Timber of this class is excellent material for pulp. Extensive areas of it are found, and it constitutes perhaps 20 per cent of the timber volume of the region.

#### SITKA SPRUCE TYPE

Sitka spruce predominates in the type which carries its name. The stands in the type are sometimes pure spruce, but more frequently have from 15 to 25 per cent of hemlock in mixture. The volume per acre often reaches 75,000 board-feet, and the average is about 40,000 board-feet.

This is not an extensive type, and the aggregate volume of timber is small in comparison with that of the hemlock-spruce type. It occurs in patches, seldom exceeding 80 acres in extent and usually much smaller. It is ordinarily the first coniferous type to be established on "new ground" and hence is common on lands being uncovered by retreating glaciers, on the alluvial deposits along the valley floors and at the outlets of large rivers and glacial streams, and on mineral soil exposed by extensive landslides on steep slopes. It is not confined to such sites, however, and is frequently found on well-drained, lower slopes. It is especially prevalent on limestone formations, perhaps because of the good drainage.

The west coast of Prince of Wales Island and the numerous adjacent small islands contain an outstanding number of spruce areas on which the trees are exceptionally large. These areas are supplying most of the present sawmill requirements of southeastern Alaska, as the trees yield a high percentage of clear lumber that can be exported profitably. Such stands are not sufficiently large and numerous to support a large sawmill industry cutting for the general markets, but they are of great value in maintaining a substantial local milling industry, dependent in part upon a certain amount of export business for successful operation.

#### CEDAR TYPE

The cedar type has western red cedar or Alaska cedar, or both, as the principal species. South of Frederick Sound the two occur in mixture, with western red cedar predominating on sites below 500 feet elevation and Alaska cedar on higher sites. North of Frederick Sound Alaska cedar alone predominates throughout the type.

The cedar type in Alaska as differentiated by forest officers includes only the cedar stands having a material present or future value. Areas of stunted trees of no value now and of questionable future value are placed in the "scrub" type, along with equally poor stands.



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FIG. 5.—Young-growth hemlock and spruce with a volume of 20,000 to 30,000 board feet per acre. This class of timber constitutes the most valuable pulpwood stands in Alaska

of stunted hemlock and spruce. The type occurs mostly as scattered patches and covers an insignificant percentage of the total forested area of the region.

## SCRUB

The term "scrub" is used to describe the open stands of somewhat dwarfed, defective trees, with dense undergrowth of blueberry and other shrubs, which occupy the soils more poorly drained than those of the forest types previously described but better drained than those of the muskeg type. Many of the trees are spike topped and highly defective, have a rapid taper and long, ragged crown, and in general present a scrubby and unhealthy appearance. All of the coniferous-tree species of the region may be represented, but the cedars usually predominate. Stands of scrub generally have many interspersed areas of muskeg, the one type merging gradually into the other. Together they are widely distributed and cover perhaps one-fourth of the total timber area of the region.

The timber of the scrub type is not considered as having any commercial value. It may, however, be drawn upon in the very distant future for pulpwood. Many clumps of good trees are scattered through the stands, and these could be logged profitably if pulpwood prices in Alaska equaled those now being paid in eastern United States. It is safe to assume that not less than an average of 8 cords per acre could be obtained from the total area of 1,000,000 acres or more of this type in southeastern Alaska.

## MUSKEG

The muskeg type consists of a vegetative cover of moss, grass, herbs, and isolated stunted trees, including lodgepole pine (*Pinus contorta*), growing on peat accumulations often 5 feet or more in thickness. As previously stated, it merges into the scrub type, and the two cover very extensive areas. It contains no commercial timber.

## SUBALPINE

The subalpine type includes the small and stunted tree growth found above the altitudinal limit of the commercial forests, which in this region is at about 1,500 feet. The species are chiefly mountain hemlock and Alaska cedar. The poor quality of the timber, the light stands, and inaccessibility prevent the type from having any commercial importance.

## SILVICULTURAL FEATURES

Sitka spruce, the most important species of this region, is a rapid-growing, light-demanding tree. It reaches its best development when growing, as it usually does, in mixture with other species, which it always overtops. Western hemlock, its principal associate, has fair growth properties and is a shade-enduring tree, the last-named quality enabling it and the more light-demanding spruce in mixture to form very dense stands. (Figs. 2 and 3.) The two are an excellent combination for the production of pulpwood, and the aim of the forester will be to reproduce both species but increase the proportion of the more valuable spruce to the point, now unknown, where its quality begins to suffer.

The original forest cover in this region was doubtless almost pure spruce. This tends to give way to hemlock. In places where glaciers have receded recently spruce is in possession of the ground, and hemlock is just beginning its invasion. On most areas in the region the forest is older, and hemlock has come in to such an extent that it forms 75 to 80 per cent of the stand. (Fig. 4.) It is thought that logging operations will have the effect of reversing the natural tendency toward a pure hemlock stand. Present indications are that the proportion of spruce in the stands coming in on cut-over areas will be as high as 50 per cent.

From a silvicultural point of view, clear cutting and the leaving of seed trees is the desirable logging method in this region. Studies of cut-over saw-timber areas plainly show that following logging by this method ample reproduction comes in through natural reseeding and that the percentage of spruce in the second crop is increased. Clear cutting is desirable for the additional reason that spruce and hemlock are shallow-rooted trees liable to excessive windthrow when not growing in closed stands. In this connection it should be stated that because of the danger of windthrow seed trees must be left in fairly large groups rather than as scattered individuals, a practice which causes little interference with logging. Fortunately clear cutting is the most practicable method of logging in these heavy forests, so that no unusual or more costly logging systems must be introduced to get proper reproduction.

It is not anticipated that the disposal of logging slash on pulp-wood cutting areas need extend further than lopping the tops so that they lie close to the ground and removing piles of slash from clumps of reproduction and from around groups of seed trees. Even these simple measures may be found unnecessary. Usually the chief purpose of slash disposal is to reduce the fire hazard to the oncoming timber crop on the cut-over areas, and in the wet climate of this region the hazard is low and does not necessitate expensive disposal work. It is not yet known whether slash disposal in any form is a help in obtaining the desired kind and quantity of reproduction in the hemlock-spruce type.

Studies of yield in the forests of southeastern Alaska have not yet progressed far enough to indicate definitely the amount of pulp timber that can be produced in a second crop in a given number of years. However, sufficient has been done to indicate that the rotation is likely to be between 85 and 100 years and that the crop produced in this period will have a volume per acre at least twice the average volume now found in the virgin commercial forest.

Estimating the commercial stand of virgin timber in southeastern Alaska at 80,000,000,000 board feet, a conservative estimate, and allowing 90 years as the rotation period during which this virgin timber will be entirely cut, approximately 1,500,000 cords of wood of 600 board feet each can be removed from the forest yearly in this period. This output is sufficient to produce not less than 1,000,000 tons of newsprint a year. As the new crop of timber in which cutting will begin after 90 years will have at least twice the volume per acre of the virgin stand, a plan of forest management based on a sustained yield of 1,500,000 cords of pulpwood should prove to be conservative.

## A SAMPLE AREA

As an illustration of typical timber conditions on a large part of the Tongass National Forest, the following data are given for the Keku unit, an area located on Kupreanof and Kuiu Islands, at the north end of Keku Straits. The unit was cruised in 1923. (Fig. 6.)

The area within the boundaries of the unit is about 300,000 acres, including the barren and nonmerchantable areas. About 148,000 acres are covered with merchantable timber.

TABLE 2.—*Estimated volume of merchantable timber, Keku unit, Tongass National Forest*

Species	Volume, feet board measure	Per cent
Sitka spruce.....	494,661,000	18
Western hemlock.....	2,222,430,000	81
Alaska cedar.....	27,664,000	1
Total.....	2,744,755,000	100

The estimate in Table 2 gives an average stand of 18,500 board feet per acre on the 148,341 acres classed as bearing merchantable timber. In cruising, the seven major topographic subdivisions of the area were called blocks, and the estimate for each was kept separately. These blocks contain an average of about 20,000 acres of merchantable timber each. The average stand by blocks ranges from 14,000 to 24,000 board feet per acre. The proportion of spruce in these blocks is very uniform, ranging from 16.3 to 19.1 per cent of the total stand. The proportion of cedar varies by blocks from 0.1 to 4.7 per cent.

The estimates given are very conservative and are more accurate as a saw-timber than a pulp-timber cruise. It is strongly believed that if this area should be logged under the present standard pulp-timber agreements for the Tongass National Forest the cut would overrun the cruise by at least 25 per cent.

A large portion of the unit, especially the northeastern part, carries a stand 75 per cent of which is clean, smooth hemlock averaging between 20 and 30 inches in diameter breast high, and 90 to 120 feet in merchantable length to a 6-inch top, together with Sitka spruce from 20 to 40 inches in diameter breast high and 95 to 150 feet in merchantable length.

The unit is best suited for pulp-timber operations. There are no extensive areas of heavy spruce stands such as are desired for saw-log production under present conditions in southeastern Alaska. Spruce and cedar saw logs and hemlock piling can be segregated into separate rafts as the scattered high-quality trees containing these products are logged during an operation primarily for pulpwood, and this will undoubtedly be done.

The area is characterized by low, rolling country, wide valleys, and gentle slopes, although steep slopes and narrow creek valleys occur in places such as the south side of Saginaw Bay, the head of Port Camden, and the sides of Mount Bendel in the northeast corner of

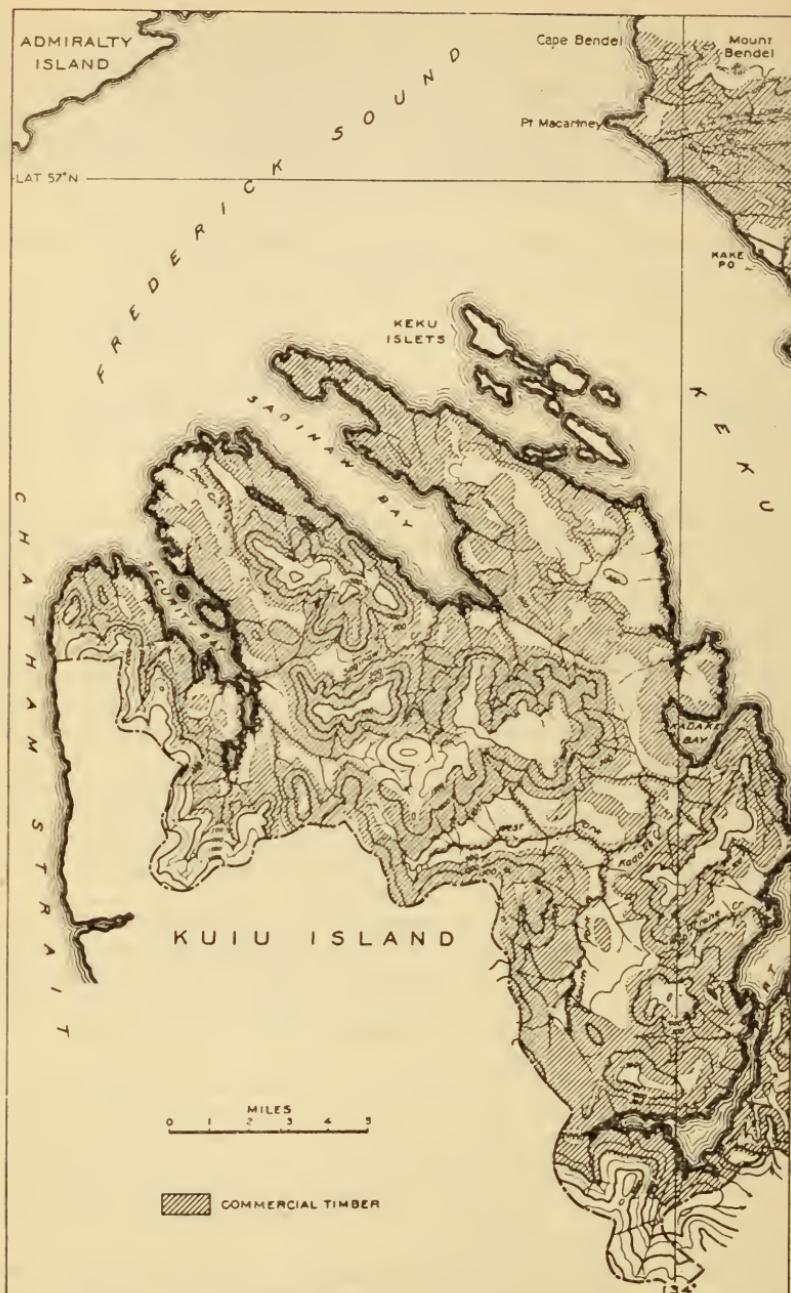
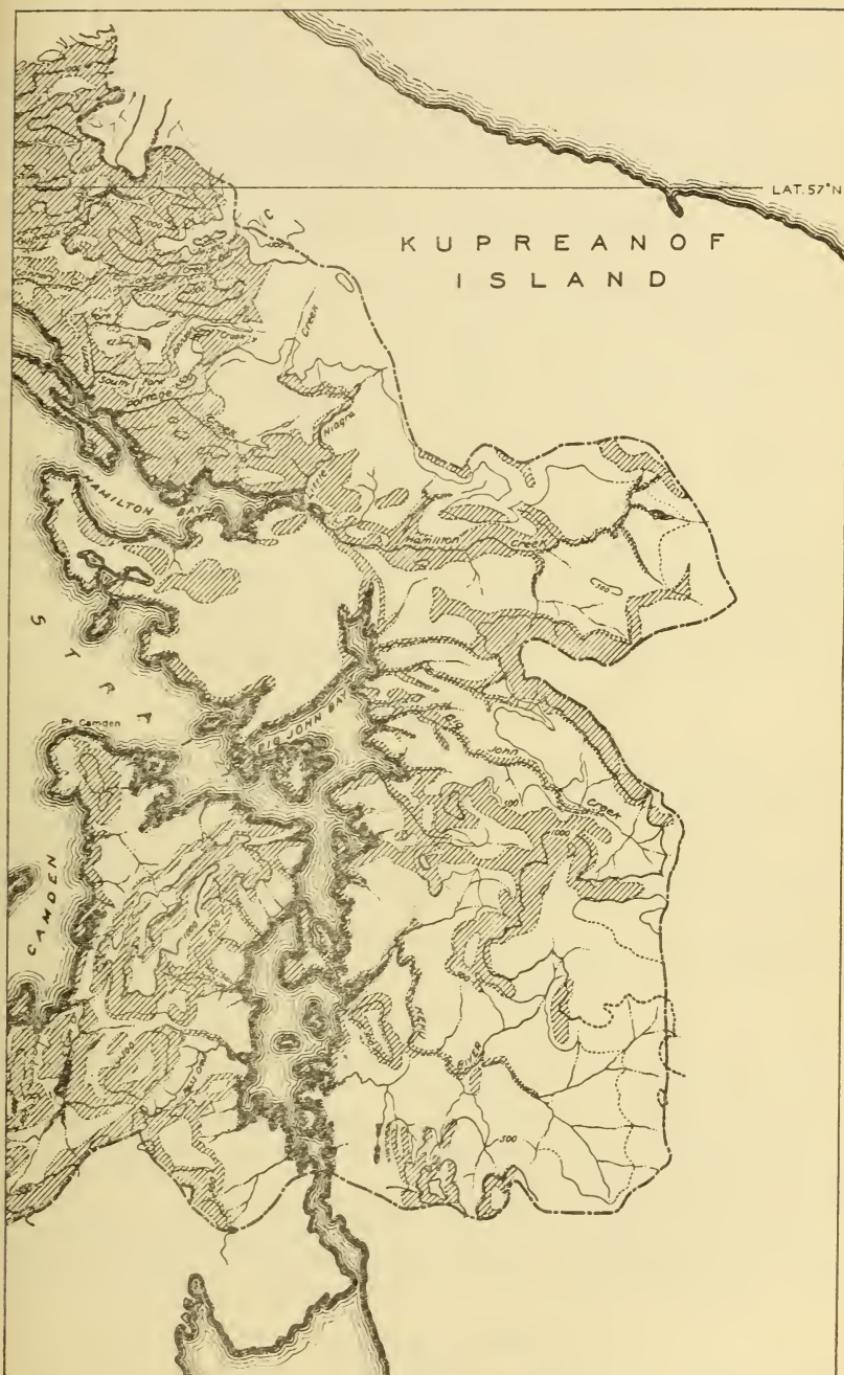


FIG. 6.—Keku pulp-timber unit,



Tongass National Forest, Alaska.

the unit. The shore line is well protected from storms and secure booming and log-storage grounds are numerous. Figure 6 shows that most of the unit is readily accessible from salt water.

Considered as a sample, the Keku unit is only fair in timber quality. A number of large units in this region surpass it in compactness and density of stand. Its chief advantage is the great amount of shore line adjacent to sheltered waters, which makes the timber readily accessible and permits of cheap and yearlong logging.

#### NATIONAL-FOREST ADMINISTRATION

The Tongass National Forest is administered by a branch of the United States Forest Service, resident in Alaska. Only important matters involving questions of general policy need be referred to Washington; most national-forest business is handled locally.

The chief administrative officer of the Alaska branch of the Forest Service is the district forester, with headquarters at Juneau. The Tongass National Forest is directly in charge of a forest supervisor, whose office is located at Ketchikan. The forest is divided into five ranger districts, with headquarters at Craig, Juneau, Ketchikan, Petersburg, and Sitka, the principal business centers of the region. Both the district forester and the forest supervisor have assistants for handling specialized and technical lines of work.

A fleet of seagoing launches (fig. 10) is maintained to provide field transportation for the Forest Service personnel.

#### FOREST-MANAGEMENT POLICY

The following is a condensed statement of the main objectives and general policies which have been established by the Forest Service for the management of the timber resources of the Tongass National Forest. They provide for a continuous and adequate supply of timber for wood-using plants that may be installed in the region. The establishment of such plants will in turn foster the permanent development of the Territory and allow of a sustained contribution to the Nation's supply of timber products.

#### OBJECT OF MANAGEMENT

The management of the timber resources of the Tongass National Forest has as its prime objectives:

The development and maintenance of a permanent pulp and paper manufacturing industry commensurate with the available water power and timber resources.

The furnishing of a permanent and convenient supply of timber for local consumption, with such an additional supply to the local sawmills for the general lumber markets as may be needed to justify efficient milling facilities and provide yearlong operations.

#### TIMBER-USE POLICY

The productive forest land, after examination and careful study, will be divided into pulp-timber allotments, local-use allotments, and general-use areas.

Pulp-timber allotments will be laid out as complementary to definite available water-power sites suitable for use in the manufacture of pulp. Each allotment will include sufficient timberland to supply a sustained annual yield of timber equal to the mill capacity obtainable through a full economic development of the accompanying water-power site or sites.

Local-use allotments will be laid out on the basis of the suitability of the timber for the common local uses and its accessibility to points of consumption. In determining the size of local-use allotments consideration will be given to the probable opportunities for the local users to get material from present or future sales on pulpwood allotments, so that the allotments will not need in all cases to be so large as to supply the entire estimated future local demands. They will, however, be sufficiently large to permit of their being managed on the principle of sustained yield, using one or several allotments as the unit of management. On these allotments timber unsuitable for local use will be disposed of on the stump for pulpwood or other purposes under small, short-term sales or will be cut along with material included in local-use sales and separated from such material after being logged.

General-use areas will include all bodies of timber not specifically placed in the two foregoing classifications. They will be available for sale for any product for the general or local market. Sustained-yield management will be practiced so far as possible.

So far as the Forest Service is able to control the location of pulp mills, they will be so distributed that an adequate timber supply under the management plan will always be available within a reasonable log-towing distance of each plant.

Initial sales within an allotment will ordinarily include those timber units most accessible to tidewater, the more inaccessible units being left for later exploitation.

Other things being equal, preference will be given to such industries and applicants as contemplate the most complete manufacture in Alaska.

Aggressive action will be taken to interest prospective investors in the pulp-timber and water-power resources. Data on location and amount of timber supplies, power resources, plant sites, transportation, labor, markets, construction costs, operating costs, and other governing factors will be gathered and made available to possible timber buyers and other interested parties.

Sawmills established primarily to supply an important local demand which may be insufficient to provide yearlong operations, permit efficient milling methods, and justify first-class equipment, will be encouraged in any efforts they may make toward the placing of the excess lumber cut on the general markets of the United States and foreign countries. The establishment of minor wood-using industries, especially those using western red cedar and Alaska cedar, will also be encouraged.

Sales of timber will not be made when it is anticipated that the wood will be exported from the Territory of Alaska in the form of logs, cordwood, or other raw product necessitating primary manufacture elsewhere. Export of raw material will, however, be allowed in individual cases where this will permit of a more complete utilization

of material on areas being logged primarily for products for local manufacture; prevent serious deterioration of logs unsalable locally because of an unforeseen loss of markets; permit the salvage of timber damaged by wind, fire, insects, or disease; or bring into use a minor species of little importance to local industrial development. No sales, except for purely local use, will be made to aliens or alien corporations.

Small sales will be encouraged so far as is consistent with the investment required and the demands of the industries. Every encouragement will be given to the establishment of a competitive log market.

#### GENERAL CONDITIONS APPLYING TO TIMBER SALES

The stumpage alone is offered for sale from the national forest, the land being retained by the United States for the production of succeeding forest crops. The timber is paid for in small installments as cutting proceeds and on the basis of a scale or measurement of the cut material made by a forest officer. The amount of each installment is approximately equal to the value of the stumpage that will be cut by the purchaser in a 2-month period of active logging.

Timber is ordinarily offered for sale on applications from interested parties, and in units of volume as desired, provided the requested unit is not unreasonably large as compared with the applicants' manufacturing or logging facilities. The sale contract covers all of the merchantable timber designated for cutting on a prescribed tract. Such a tract always consists of a complete logging unit; that is, a unit from which all of the merchantable timber should logically be taken in one logging operation.

The timber of the unit applied for is appraised by a forest officer on the basis of its value after manufacture into the usual timber products of the region minus the cost of logging and manufacturing and a reasonable margin for profit and risk under the prevailing local conditions. The timber is then advertised for sale by sealed bids for a period of not less than 30 days, as required by law, the advertisement naming the appraised stumpage rates as the minimum that will be considered.<sup>3</sup> The timber is awarded to the highest bidder who can make a satisfactory showing of ability, financial and otherwise, to carry the proposed operations through to completion.

The stumpage prices now being received for national-forest timber in Alaska vary with the species, quality, and accessibility. Sitka spruce, western red cedar, and Alaska cedar for sawmill use often sell for \$1.50 per 1,000 board feet, but \$2 per 1,000 board feet is obtained for some of the better stands of spruce. Hemlock for the same use averages \$1 per 1,000 board feet. Piling of any species varies in price from 1 cent to 1½ cents per linear foot, according to the length of the sticks. The successful bids for the two large sales of pulp timber awarded in 1927 carried the following rates: For the Ketchikan project, 80 cents per cord of 100 cubic feet for spruce and 40 cents per cord for hemlock; for the Juneau project, 60 cents per cord for spruce and 30 cents for hemlock.

<sup>3</sup> Timber sales involving less than \$500 in stumpage may be sold by private sale without advertisement. Settlers, miners, residents, and prospectors are permitted to take for their own use 10,000 board-feet of saw timber and 25 cords of wood annually, free of charge, from the national forests of Alaska.

The bid stumpage rates in every long-term sale apply for a limited period only and are subject to readjustment at stated intervals throughout the life of the contract to bring them into conformity with the then current value of stumpage in southeastern Alaska.

The two large pioneer pulp-timber contracts that were awarded in 1927 provide that the rates will not be subject to change until after the first 10 years of operation, but at the end of that period and at 5-year intervals thereafter they may be readjusted; also definite figures are named as the maximum rates that may be established to apply during the two 5-year periods next following the initial 10-year period. At no time can readjusted rates, higher than those bid by the purchaser, be established which, so far as can be determined by the Forest Service, will result in making the cost of southeastern Alaska paper delivered at the large paper-consuming centers higher than the delivered cost of paper of the same kind produced by mills in other paper-making regions of the Pacific coast. In readjusting rates due recognition must be given to the quality and accessibility of the timber included in the particular contract and to any other physical condition affecting the operations of the purchaser.

The maximum amount of timber that will be placed under contract to one firm and the period of time allowed for its removal from the sale area are governed by the purchaser's logging and manufacturing investment, practical operating methods, and markets. Five billion board feet of timber each and a cutting period of 50 years were authorized for each of the two pioneer pulp contracts mentioned above.

National-forest timber is sold for use and can not be held for speculation or other purposes. Hence long-term contracts specify a definite date by which logging must begin, and provide that certain minimum amounts be cut in given periods.

Timber is sold on the basis of the unit customarily used in the industry concerned. Thus, saw timber is sold by the board foot, piling and poles by the linear foot, fuel by the cord, etc. The pulp-timber unit almost universally used in the industry is the cord, but as pulpwood in Alaska will ordinarily come to the mills in long logs and not be reduced to cordwood form, the cubic foot has been selected as a simple, suitable unit, easily applied. The price unit for pulp timber is 100 cubic feet of solid wood (excluding bark and rot), an amount approximately equal to a cord.

Contracts provide for clear cutting the merchantable timber on the sale area with the exception that not to exceed 5 per cent of the volume may be reserved for reseeding purposes. The seed trees to be reserved are selected by forest officers, are ordinarily left in small groups rather than as scattered individuals, and must be protected against injury during logging operations.

The Forest Service reserves the right to require the disposal of logging débris to the extent of lopping the tops and scattering the brush so that it lies close to the ground and away from seed trees and clumps of reproduction. Satisfactory precautions must be taken against the escape of fire from logging operations.

A surety bond may be required of a purchaser to insure compliance with the terms of the contract. Such bonds, equal in amount

to 5 per cent of the value of the timber under contract but with a maximum for any bond of \$50,000, must always be furnished in large sales.

#### WATER-POWER RESOURCES

Southeastern Alaska has excellent water-power resources for industrial use and especially for the manufacture of pulp and paper. Over 450,000 horsepower has been covered by reconnaissance surveys to date, and further power explorations are almost certain to disclose additional important units. The largest single power site so far investigated has a year-long capacity of 32,000 horsepower. In many places power from a number of sites can be economically concentrated at one manufacturing point. For example, 50,000 horsepower can be developed in one power house from two sites adjacent to the head of Speel River arm of Port Snettisham near Juneau and the development of two other sites in the same locality would increase the concentration at this point to a total of 75,000 horsepower. Three sites adjacent to the head of Bradfield Canal near the town of Wrangell have a combined capacity of 54,000 horsepower. The largest and most accessible of the three will provide 23,000 horsepower, and the energy from the other two sites can be added by the use of 10 miles of transmission line paralleling tidewater.

In 1915 the United States Forest Service and the Geological Survey began a cooperative study of the stream flow on the known water powers of southeastern Alaska with the result that good year-round flow records for an extended period of years are now available for many sites. In 1921 and 1922, the Federal Power Commission and the Forest Service cooperated in a reconnaissance of these powers to determine power capacities and methods and costs of development. The results of these surveys, the stream-flow records, and other pertinent data relating to power development are given in Federal Power Commission Bulletin, *The Water Powers of Southeastern Alaska*, by J. C. Dort.<sup>4</sup>

The outstanding characteristics of the water powers of this region are as follows: High-head developments, short conduits, small drainage basins with heavy run-off, good water-storage facilities, accessibility of the projects to navigable waters, and the opportunity to locate industrial plants either directly at the power-house sites or within very short power-transmission distances.

The typical water-power site has a high "hanging" lake located a short distance inland from tidewater. (Fig. 7.) This can be made to serve as a storage reservoir by the use of a dam across the lake outlet, by a tunnel to tap the lake below its present water surface, or by a combination of these two methods. Many of the lakes have elevations exceeding 500 feet. Conduits to connect the lakes with power houses at tidewater will range from one-fourth mile to 3 miles in length and in most cases will be less than 1½ miles long.

The run-off per square mile of drainage basin is very high because of heavy precipitation in this region. The normal period of low

<sup>4</sup> DORT, J. C. *Op. cit.*

stream flow occurs in winter, when the precipitation on the high watersheds is largely held in suspension in the form of snow, so that extensive water storage for winter use is necessary to obtain the high, regulated flow throughout the year which is essential for a pulp and paper plant. All of the sites considered suitable for pulp and paper projects have lake storage and the possibility for such regulation of the flow. Many of the power streams are fed by perpetual snow fields, which sustain the water flow materially during any prolonged dry periods in summer.

The following data apply to a water power of the better class:

*Location.*—Cascade Creek, Thomas Bay, Tongass National Forest.

*Reservoir.*—Swan Lake. Area 614 acres, elevation 1,487 feet, depth 425 feet at points near the shore.



FIG. 7.—Sweetheart Lake. A typical power site of this region. A natural reservoir fed by permanent snow fields, located 2 miles from tidewater, at an elevation of 531 feet. It can be developed to furnish 17,500 horsepower continuously throughout the year. This is one of four power sites adjacent to Port Snettisham that can provide a total of 75,000 horsepower.

*Dam.*—At lake outlet, 100 feet high, rock-filled type, 65,000 cubic yards of rock required. Would provide complete regulation of the flow.

*Conduit.*—13,500 feet of pressure tunnel and 2,800 feet of pipe from lake to tidewater.

*Head.*—Average static head, 1,537 feet.

*Power discharge.*—193 second-feet, regulated discharge. Stream-flow records available since October, 1917.

*Power capacity.*—23,700 mechanical horsepower at 70 per cent efficiency and 100 per cent utilization.

*Estimated cost.*—\$56 per mechanical horsepower.

The Federal Power Commission has jurisdiction under the Federal water power act of June 10, 1920, over all water-power development in the United States where the projects involve lands or waters in which the Federal Government has an interest. It therefore exercises supervision over the development and use of power sites located

on the national forests and the public domain of Alaska. The district forester at Juneau acts as the Alaska representative of the commission.

The Federal water power act provides for the development and use of power sites under a form of license calling for a nominal, annual rental fee per horsepower developed and covering a period not in excess of 50 years. Licenses are renewable under certain conditions at the end of the period for which granted. After bona fide construction has begun a license can be revoked only by a decree of a Federal court.

Owing to the close relationship in paper-making projects between water-power development and the use of timber resources, the Federal Power Commission and the Forest Service coordinate their actions on applications for such projects in southeastern Alaska. The power site or sites and the appurtenant timber supply are awarded to one concern, and the requirements for development and use are harmonized.

#### TRANSPORTATION FACILITIES

The Alaska Steamship Co. and the Pacific Steamship Co. provide year-round transportation between Seattle and all ports in southeastern Alaska, operating combined passenger and freight vessels, as well as many strictly cargo carriers. The Canadian Pacific and Canadian National Railroads operate four to six vessels from Vancouver, British Columbia, in the passenger trade of this region during the summer months, but this service in winter is reduced to one boat. The average interval between arrivals from the south of passenger vessels at southeastern Alaska ports is one day from June to September and three days during the remainder of the year.

The network of protected sea channels in this region is admirably suited to the use of small motor-driven boats. The various centers of population are connected by common-carrier boats of this type, and all industrial enterprises make use of motor-driven work boats. As this network of sea channels extends south to Puget Sound, small tugs with barges and flat scows are used extensively to transport coal, lumber, ore, canned salmon, and other products to and from Seattle. There is an excellent opportunity to operate a railroad-car ferry or barge service between Alaskan ports and Prince Rupert, British Columbia, a western terminus of the Canadian National Railroad, and to ship Alaska pulp and paper by this short route to the Middle Western States.

The pulp and paper markets of the Orient and Australia are as readily accessible to Alaska as to the Pacific Coast States and British Columbia. Those of the Gulf States and other sections of the Atlantic seaboard can be reached by water shipments through the Panama Canal.

Approximate distances from Ketchikan, the most southerly Alaska port, to some important points are as follows:

	Miles
Minneapolis, via Prince Rupert, British Columbia, and Canadian National Railroad	2,390
Chicago, via Prince Rupert, British Columbia, and Canadian National Railroad	2,700

	Miles
Seattle	660
San Francisco	1,300
Colon	4,638
New Orleans, via Panama Canal	6,084
Savannah, via Panama Canal	6,407
New York, via Panama Canal	6,663
Honolulu	2,450
Yokohama	3,911
New Zealand	6,550
Sydney, Australia	6,850

### LOGGING METHODS AND COSTS

Machine logging with donkey engines and wire rope is the only practical means of moving logs from the woods in this region because of the rough topography, the large quantity of débris on the ground, and the large size of many of the trees. (Fig. 8.) Ground-skidding and high-lead systems are now used, but one of the overhead systems will probably prove most economical for extensive pulpwood operations. The methods of logging required in Alaska are similar to those used in Washington and Oregon, and the necessary machinery and supplies are manufactured in those States.

A large percentage of the timber can be logged directly into tidewater by the use of two and three donkey engines working tandem. Log flumes, short railroads, or motor-truck roads will be required to move the timber from the logging engines to tidewater in the longer valleys, but these more extensive logging areas need not be tapped for pulp-wood supplies in the early years of the paper industry in Alaska. Log driving is not practicable in the short turbulent streams.

Timber is handled in full-tree lengths or as very long logs from the stump to the mill. After being pulled to tidewater by donkey engines it is towed in the form of flat rafts through the protected waterways. (Figs. 9 and 10.) The cost of towing saw logs is about 1 cent per 1,000 board feet per mile. The cost for pulpwood per cord should not exceed this figure, and it may be somewhat less. Timber supplies can thus be drawn from a very extensive region surrounding a plant without incurring an excessive transportation cost.

Floating logging camps, which can be easily towed from one cutting area to another, are in general use. Similarly, donkey engines and all other logging equipment are moved on scows and floats.

The average cost of saw logs, exclusive of stumpage, delivered at the sawmills in 1927 was about \$9 per 1,000 board feet. It is estimated that the total cost of unpeeled pulpwood logs delivered at local mills and including an average stumpage charge of 40 cents per cord will not exceed \$6 per cord (equivalent to \$10 per 1,000 board feet) during the next 10 years, on the basis of labor and equipment costs of 1927.

### EXISTING FOREST INDUSTRIES

Practically all of the timber used in southeastern Alaska is purchased from the national forest. The annual cut of the forest has



FIG. 8.—Machine logging with donkey engines and wire rope is the practice in Alaska, as in other sections of the Pacific coast. The engines are towed from one area to another on heavy log floats of the type shown in the picture. All logging-camp buildings are placed permanently on floats and can thus be moved readily between operating areas.

increased from 6,000,000 board feet in 1909 to 52,000,000 board feet in 1927, with a total for this period of 680,000,000 board feet. The greater part of the present output goes into lumber, but about 20 per cent is used in the round for fish-trap and wharf piling. Juneau and Ketchikan have each a modern electric-driven sawmill of 100,000 board-feet capacity per 8-hour day. A mill at Wrangell has a capacity of 70,000 board feet per day. A second mill at Ketchikan produces 25,000 board feet daily, and one of equal size is located at Hyder. Numerous smaller mills cutting less than 10,000 board feet daily and operated intermittently are found in the smaller communities and in connection with mining and other industrial projects.

Most of the forest products manufactured are consumed locally by the fishing and mining industries. As the local lumber require-



FIG. 9.—A scow loaded with 400,000 board feet of clear spruce lumber to be towed from Juneau to Seattle. The log rafts in the background show the inexpensive type of rafting that can be employed in long-distance towing in Alaska owing to the protected waterways.

ments are confined almost entirely to the lower and middle grades, the three largest mills, which are in a position to cut and market their output by grade, are shipping a considerable and increasing amount of spruce uppers to the general markets of the United States and foreign countries. The shipment of lumber from the Territory originated during the World War, when much high-grade Alaska spruce was produced for airplane construction.

An extensive sawmill development primarily for entering the general markets is considered inadvisable. The pure stands of high-grade spruce saw timber are too limited to support a large industry, and it is unlikely that the mill-run of lumber from the predominating hemlock-spruce forests can compete with the material of the same species produced in southern British Columbia, Washington, and Oregon. The trees of the hemlock-spruce stands in Alaska are

smaller and give less clear stock; the greater distance from market is a very important factor in handling a heavy low-grade product, and there are other drawbacks, such as lack of any local market for by-products. The sawmill capacity in Alaska should be gauged to the local demand, and if this is done the supply of high-grade saw timber is sufficient to maintain a thriving lumber industry. The common lumber can be sold locally, and the clears produced from this select timber will stand the shipping charge to the general markets outside the Territory.

The hemlock-piling industry offers no chance of expansion as the present operators are fully able to meet the local needs and piling can not be shipped out of the Territory at a profit.

A market can undoubtedly be developed for Alaska cedar. The wood of this tree is somewhat similar to that of Port Orford cedar and is suitable for many of the products for which that valuable



FIG. 10.—Forest rangers sealing a raft of spruce logs en route to a sawmill. The waterways furnish the "main-line" transportation in Alaska, making expensive logging railroads unnecessary.

species is used. The manufacture of articles such as moth-repellent chests, battery boxes, or battery separators from Alaska cedar could probably be made an important minor industry in southeastern Alaska, or that region could produce rough shapes for remanufacture and finishing elsewhere.

The manufacture of shingles is now confined to two small plants cutting solely for the local trade. In the future this should develop into an important industry, as the region has a large amount of western red cedar of shingle grade. The production of cedar telephone poles is also a possibility. Logging primarily for poles is practical in some places, but as a general rule poles will be obtained in connection with logging operations for other products. Shingles and poles should be marketed to best advantage in the prairie Provinces of Canada and the Middle Western States, with shipment through Prince Rupert, British Columbia.

Alaska has no operating pulp or paper mills at the present time. The nearest pulp mill is a sulphite plant at Swanson Bay, British Columbia, 212 miles south of Ketchikan. The newsprint plant of Pacific Mills (Ltd.), having a capacity of over 300 tons daily, is located at Ocean Falls, British Columbia, 296 miles south of Ketchikan.

### POSSIBILITIES FOR THE PULP AND PAPER INDUSTRY

The extensive forest resources of southeastern Alaska will undoubtedly be exploited chiefly for the manufacture of newsprint paper because of unusually favorable conditions there for the large-scale operations that now characterize that industry. Conditions are not favorable for other branches of the paper industry or for the extensive manufacture of lumber.

Studies by the Forest Service indicate that the forests of this region, under a proper system of management, can produce not less than 1,500,000 cords of pulpwood annually in perpetuity. In other words, this amount of timber can be logged yearly and will be fully renewed through tree growth. Converted into newsprint this represents a production of 1,000,000 tons, or more than one-fourth of the present yearly consumption in the United States.

The policy of the Forest Service in limiting the development of wood-using plants dependent on national-forest timber to the total capacity that can be supplied indefinitely through tree growth insures permanent industries for this region. It prevents that overdevelopment and subsequent collapse through timber exhaustion that has characterized timber industries in many sections of the United States, and is highly important to paper companies with their heavy capital investments that can be justified only by an assuredly long operating life.

The United States has long been the world's greatest user of newsprint. The consumption is constantly growing, and for 1927 was 3,460,000 tons, or about 58 pounds per capita. To meet the increased demand and to offset production losses, due to timber depletion around old plants, the industry has reached farther and farther afield from the great consuming center represented by the eastern United States. The virgin forests capable of supplying the spruce, hemlock, and true firs, so essential for the mechanical and sulphite pulp used in newsprint have long since been followed across the border into eastern Canada, and this migration has now reached the stage where the greater part of the newsprint requirements of the United States are supplied by Canadian mills.

This expansion of the industry into the region next in accessibility to the large markets, though on foreign soil, was a logical development. But the projects of outstanding merit in eastern Canada have now largely been taken up. Those remaining apparently possess no advantages for supplying paper to the eastern markets that can not be offset by other advantages enjoyed by plants operating in the Pacific Northwest and Alaska, and shipping on a relatively cheap per ton-mile rate by vessel through the Panama Canal.

The outstanding advantages of southeastern Alaska as a location for manufacturing newsprint are water transportation to the markets of the world and abundant water power and timber resources which are available for bona fide development and use under reasonable agreements with the United States. These advantages are sufficient to assure the establishment of a large, permanent paper-making industry in the region.

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November 28, 1928

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<i>District 8</i> -----	CHARLES H. FLORY, <i>District Forester</i> .

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